LABORATORY REPORT

Application Development Lab (CS33002)

B.Tech Program in ECSc

Submitted By

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Experiment Number	2
Experiment Title	Machine Learning for Cat and Dog Classification
Date of Experiment	14/01/2025
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1. Objective:-

To classify images as cats or dogs using machine learning models.

2. Procedure:-

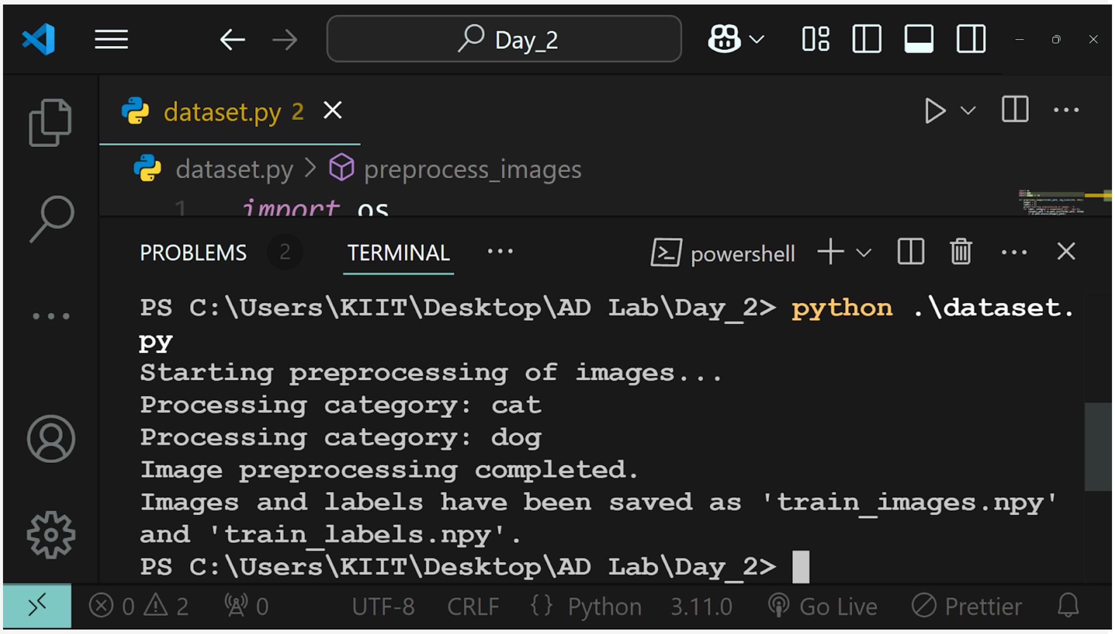
1. Collect a labeled dataset of cat and dog images.
2. Preprocess images using OpenCV (resize, flatten, etc.).
3. Train ML models: SVM, Random Forest, Logistic Regression, CNN, and K-means Clustering.
4. Save the trained models.
5. Build a Flask backend to load models and handle image uploads.
6. Create a frontend with HTML/CSS for uploading images and selecting models..
7. Display the classification result on the webpage.

3. Code:-

i. Program for labeling dataset of Cat and Dog images :

(dataset.py)

```python
import os
import cv2
import numpy as np

def preprocess_images(folder_path, img_size=(128, 128)):
    images = []
    labels = []
    print("Starting preprocessing of images...")
    for label, category in enumerate(['cat', 'dog']):
        category_path = os.path.join(folder_path, category)
        if os.path.exists(category_path):
            print(f"Processing category: {category}")
            for file in os.listdir(category_path):
                file_path = os.path.join(category_path, file)
                img = cv2.imread(file_path)
                if img is not None:
                    img = cv2.resize(img, img_size)
                    img = img / 255.0
                    img = img.flatten()
                    images.append(img)
                    labels.append(label)
                else:
                    print(f"Could not read image: {file_path}")
        else:
            print(f"Folder not found: {category_path}")
    print("Image preprocessing completed.")
    return np.array(images), np.array(labels)

if __name__ == "__main__":
    dataset_path = r"C:\\Users\\KIIT\\Desktop\\AD Lab\\Day_2\\animals"
    train_images, train_labels = preprocess_images(dataset_path)
    np.save("train_images.npy", train_images)
    np.save("train_labels.npy", train_labels)
    print("Images and labels have been saved as 'train_images.npy' and 'train_labels.npy'.")
```



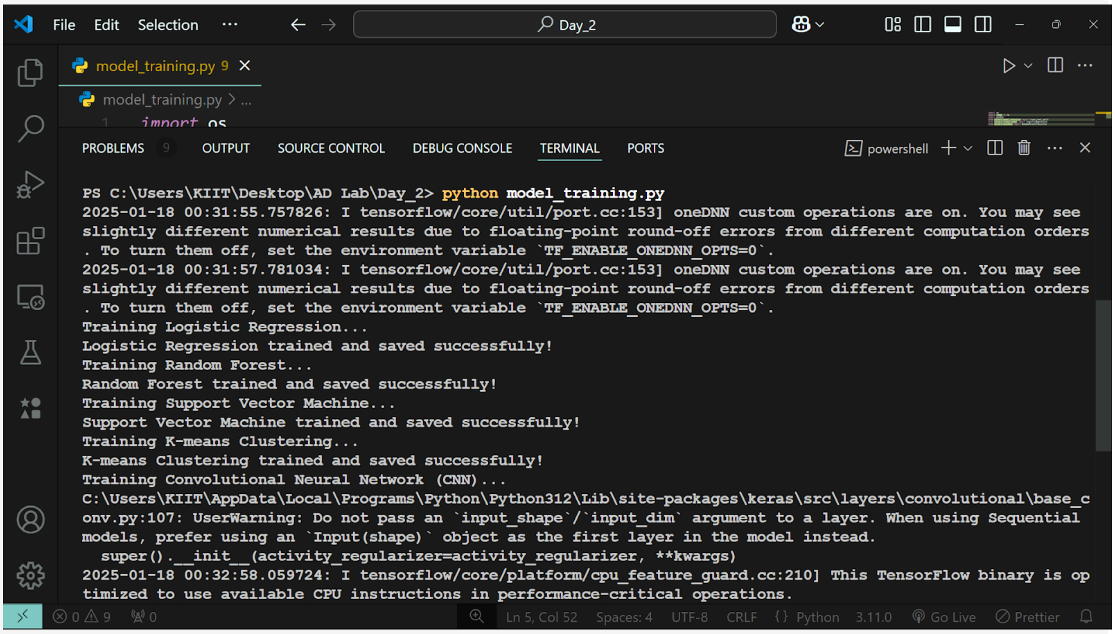
```
PS C:\Users\KIIT\Desktop\AD Lab\Day_2> python .\dataset.py
Starting preprocessing of images...
Processing category: cat
Processing category: dog
Image preprocessing completed.
Images and labels have been saved as 'train_images.npy' and 'train_labels.npy'.
PS C:\Users\KIIT\Desktop\AD Lab\Day_2>
```

ii. Program for Training & Saving ML models:

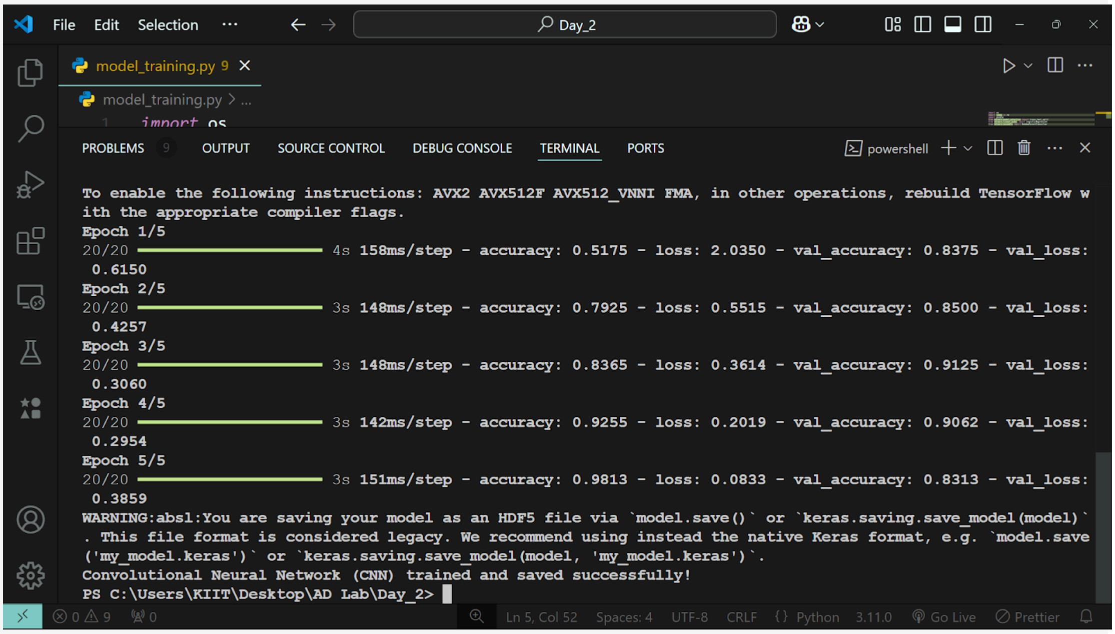
SVM, Random Forest, Logistic Regression, CNN, and K-means Clustering :

(model_training.py)

```
import os
import numpy as np
import pickle
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn.cluster import KMeans
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D,
Flatten, Dense
from tensorflow.keras.optimizers import Adam

def train_models():
    train_images = np.load("train_images.npy")
    train_labels = np.load("train_labels.npy")
    X_train, X_test, y_train, y_test = train_test_split(
            train_images.reshape(train_images.shape[0], -1),
train_labels, test_size=0.2, random_state=42)

    models = {}

    os.makedirs("saved_models", exist_ok=True)

    print("Training Logistic Regression...")
    log_reg = LogisticRegression(max_iter=1000)
    log_reg.fit(X_train, y_train)
                                        pickle.dump(log_reg,
open("saved_models/logistic_regression.pkl", "wb"))
    models['logistic_regression'] = log_reg
          print("Logistic Regression trained and saved
successfully!")

    print("Training Random Forest...")
    rf = RandomForestClassifier(n_estimators=100)
    rf.fit(X_train, y_train)
      pickle.dump(rf, open("saved_models/random_forest.pkl",
"wb"))
    models['random_forest'] = rf
    print("Random Forest trained and saved successfully!")

    print("Training Support Vector Machine...")
    svm = SVC(kernel='linear')
    svm.fit(X_train, y_train)
    pickle.dump(svm, open("saved_models/svm.pkl", "wb"))
    models['svm'] = svm
        print("Support Vector Machine trained and saved
successfully!")

    print("Training K-means Clustering...")
    kmeans = KMeans(n_clusters=2, random_state=42)
    kmeans.fit(X_train)
        pickle.dump(kmeans, open("saved_models/kmeans.pkl",
"wb"))
    models['kmeans'] = kmeans
          print("K-means Clustering trained and saved
successfully!")

    print("Training Convolutional Neural Network (CNN)...")
    cnn_model = Sequential([
                   Conv2D(32, (3, 3), activation='relu',
input_shape=(128, 128, 3)),
        MaxPooling2D((2, 2)),
        Conv2D(64, (3, 3), activation='relu'),
        MaxPooling2D((2, 2)),
        Flatten(),
        Dense(128, activation='relu'),
        Dense(2, activation='softmax')
    ])
                         cnn_model.compile(optimizer=Adam(),
loss='sparse_categorical_crossentropy',
metrics=['accuracy'])
    cnn_model.fit(X_train.reshape(-1, 128, 128, 3), y_train,
epochs=5, validation_split=0.2)
    cnn_model.save("saved_models/cnn_model.h5")
    print("Convolutional Neural Network (CNN) trained and saved successfully!")

if __name__ == "__main__":
    train_models()
```



```
PS C:\Users\KIIT\Desktop\AD Lab\Day_2> python model_training.py
2025-01-18 00:31:55.757826: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see
slightly different numerical results due to floating-point round-off errors from different computation orders
. To turn them off, set the environment variable `TF_ENABLE_ONEDNN_OPTS=0`.
2025-01-18 00:31:57.781034: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see
slightly different numerical results due to floating-point round-off errors from different computation orders
. To turn them off, set the environment variable `TF_ENABLE_ONEDNN_OPTS=0`.
Training Logistic Regression...
Logistic Regression trained and saved successfully!
Training Random Forest...
Random Forest trained and saved successfully!
Training Support Vector Machine...
Support Vector Machine trained and saved successfully!
Training K-means Clustering...
K-means Clustering trained and saved successfully!
Training Convolutional Neural Network (CNN)...
C:\Users\KIIT\AppData\Local\Programs\Python\Python312\Lib\site-packages\keras\src\layers\convolutional\base_c
onv.py:107: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential
models, prefer using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
2025-01-18 00:32:58.059724: I tensorflow/core/platform/cpu_feature_guard.cc:210] This TensorFlow binary is op
timized to use available CPU instructions in performance-critical operations.
```



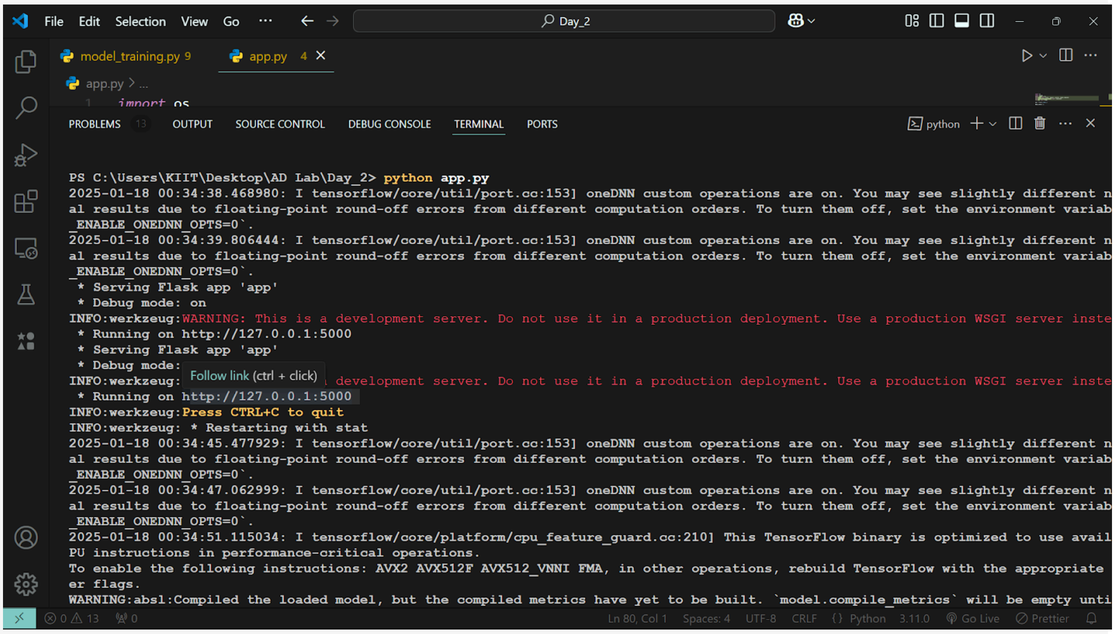
```
To enable the following instructions: AVX2 AVX512F AVX512_VNNI FMA, in other operations, rebuild TensorFlow w
ith the appropriate compiler flags.
Epoch 1/5
20/20 ━━━━━━━━━━━━━━━━━━━━ 4s 158ms/step - accuracy: 0.5175 - loss: 2.0350 - val_accuracy: 0.8375 - val_loss:
 0.6150
Epoch 2/5
20/20 ━━━━━━━━━━━━━━━━━━━━ 3s 148ms/step - accuracy: 0.7925 - loss: 0.5515 - val_accuracy: 0.8500 - val_loss:
 0.4257
Epoch 3/5
20/20 ━━━━━━━━━━━━━━━━━━━━ 3s 148ms/step - accuracy: 0.8365 - loss: 0.3614 - val_accuracy: 0.9125 - val_loss:
 0.3060
Epoch 4/5
20/20 ━━━━━━━━━━━━━━━━━━━━ 3s 142ms/step - accuracy: 0.9255 - loss: 0.2019 - val_accuracy: 0.9062 - val_loss:
 0.2954
Epoch 5/5
20/20 ━━━━━━━━━━━━━━━━━━━━ 3s 151ms/step - accuracy: 0.9813 - loss: 0.0833 - val_accuracy: 0.8313 - val_loss:
 0.3859
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`
. This file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save
('my_model.keras')` or `keras.saving.save_model(model, 'my_model.keras')`.
Convolutional Neural Network (CNN) trained and saved successfully!
PS C:\Users\KIIT\Desktop\AD Lab\Day_2> 
```

iii. Program for backend to load models and handle image uploads: (app.py)

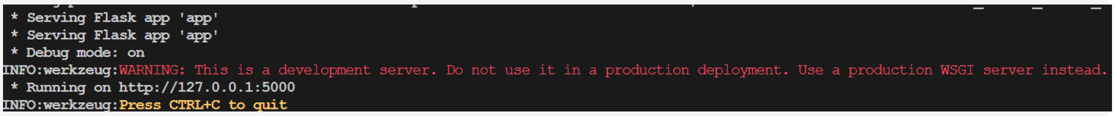
```
import os
import pickle
import numpy as np
from flask import Flask, request, jsonify, render_template
from tensorflow.keras.models import load_model
from PIL import Image

app = Flask(__name__)

MODEL_PATHS = {
    'cnn': 'saved_models/cnn_model.h5',
    'logreg': 'saved_models/logistic_regression.pkl',
    'svm': 'saved_models/svm.pkl',
    'rf': 'saved_models/random_forest.pkl',
    'kmeans': 'saved_models/kmeans.pkl'
}

models = {
    'cnn': load_model(MODEL_PATHS['cnn']),
          'logreg':   pickle.load(open(MODEL_PATHS['logreg'],
'rb')),
    'svm': pickle.load(open(MODEL_PATHS['svm'], 'rb')),
    'rf': pickle.load(open(MODEL_PATHS['rf'], 'rb')),
    'kmeans': pickle.load(open(MODEL_PATHS['kmeans'], 'rb'))
}

MODEL_ACCURACIES = {
    'cnn': 95.0,
    'logreg': 85.0,
    'svm': 88.0,
    'rf': 90.0,
    'kmeans': 80.0
}

def allowed_file(filename):
    """Check if the file has an allowed extension."""
```

```
        return '.' in filename and filename.rsplit('.',
1)[1].lower() in {'png', 'jpg', 'jpeg'}

@app.route('/')
def index():
    """Render the main page."""
    return render_template('index.html')

@app.route('/predict', methods=['POST'])
def predict():
    """Handle image upload and model prediction."""
    if 'file' not in request.files:
        return jsonify({'error': 'No file part in the
request'}), 400

    file = request.files['file']
    model_name = request.form.get('model')

    if file.filename == '':
        return jsonify({'error': 'No file selected for
uploading'}), 400

    if file and allowed_file(file.filename):
        filepath = os.path.join('uploads', file.filename)
        file.save(filepath)

        img = Image.open(filepath).resize((128, 128))
        img_array = np.array(img) / 255.0
        img_flat = img_array.reshape(1, -1)

        if model_name == 'cnn':
            prediction =
np.argmax(models['cnn'].predict(img_array.reshape(1, 128,
128, 3)))
        else:
            prediction =
models[model_name].predict(img_flat)[0]


        result = 'Cat' if prediction == 0 else 'Dog'
        accuracy = MODEL_ACCURACIES.get(model_name, 'N/A')
```

```python
        return jsonify({
            'result': result,
            'model': model_name.upper(),
            'accuracy': accuracy,
            'image_url': filepath
        })
    else:
        return jsonify({'error': 'Allowed file types are png, jpg, jpeg'}), 400

if __name__ == '__main__':
    os.makedirs('uploads', exist_ok=True)
    app.run(debug=True)
```



```
PS C:\Users\KIIT\Desktop\AD Lab\Day_2> python app.py
2025-01-18 00:34:38.468980: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see slightly different n
al results due to floating-point round-off errors from different computation orders. To turn them off, set the environment variab
_ENABLE_ONEDNN_OPTS=0`.
2025-01-18 00:34:39.806444: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see slightly different n
al results due to floating-point round-off errors from different computation orders. To turn them off, set the environment variab
_ENABLE_ONEDNN_OPTS=0`.
 * Serving Flask app 'app'
 * Debug mode: on
INFO:werkzeug:WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server inste
 * Running on http://127.0.0.1:5000
 * Serving Flask app 'app'
 * Debug mode:
INFO:werkzeug:                      development server. Do not use it in a production deployment. Use a production WSGI server inste
 * Running on http://127.0.0.1:5000
INFO:werkzeug:Press CTRL+C to quit
INFO:werkzeug: * Restarting with stat
2025-01-18 00:34:45.477929: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see slightly different n
al results due to floating-point round-off errors from different computation orders. To turn them off, set the environment variab
_ENABLE_ONEDNN_OPTS=0`.
2025-01-18 00:34:47.062999: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see slightly different n
al results due to floating-point round-off errors from different computation orders. To turn them off, set the environment variab
_ENABLE_ONEDNN_OPTS=0`.
2025-01-18 00:34:51.115034: I tensorflow/core/platform/cpu_feature_guard.cc:210] This TensorFlow binary is optimized to use avail
PU instructions in performance-critical operations.
To enable the following instructions: AVX2 AVX512F AVX512_VNNI FMA, in other operations, rebuild TensorFlow with the appropriate
er flags.
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be built. `model.compile_metrics` will be empty unti
```



```
* Serving Flask app 'app'
* Serving Flask app 'app'
* Debug mode: on
INFO:werkzeug:WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
* Running on http://127.0.0.1:5000
INFO:werkzeug:Press CTRL+C to quit
```

iv. ***Program for frontend for uploading images and selecting models:***

(index.html)

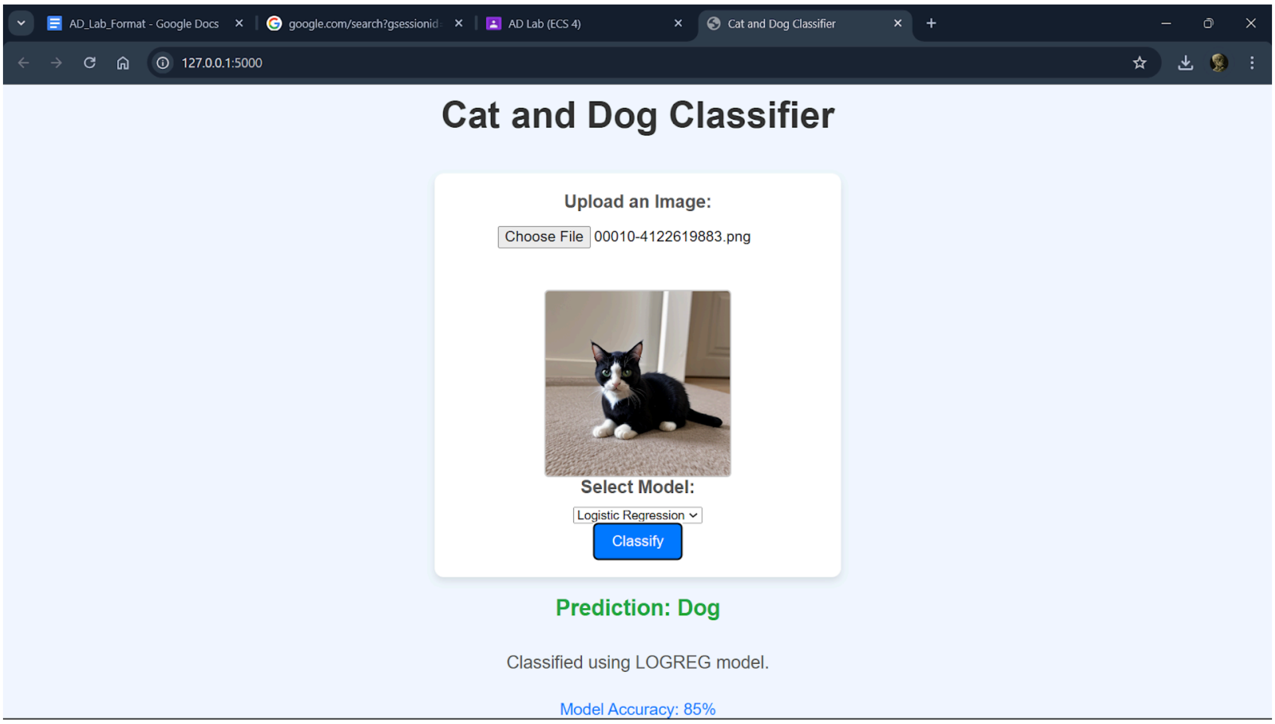
```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Cat and Dog Classifier</title>
    <style>
        body {
            font-family: Arial, sans-serif;
            background-color: #f0f8ff;
            margin: 0;
            padding: 0;
            display: flex;
            justify-content: center;
            align-items: center;
            height: 100vh;
            flex-direction: column;
        }

        h1 {
            color: #333;
            font-size: 2.5em;
            margin-bottom: 20px;
        }

        form {
            display: flex;
            flex-direction: column;
            align-items: center;
            background: white;
            padding: 20px;
            border-radius: 10px;
            box-shadow: 0px 4px 8px rgba(0, 0, 0, 0.1);
            width: 400px;
            margin-top: 20px;
```

```css
    }

    label {
        font-weight: bold;
        margin-bottom: 10px;
        font-size: 1.2em;
        color: #555;
    }

    input[type="file"] {
        padding: 5px;
        margin-bottom: 20px;
        font-size: 1em;
    }

    button {
        background-color: #007bff;
        color: white;
        font-size: 1em;
        padding: 10px 20px;
        border: none;
        border-radius: 5px;
        cursor: pointer;
        transition: background-color 0.3s;
    }

    button:hover {
        background-color: #0056b3;
    }

    img {
        margin-top: 20px;
        max-width: 100%;
        max-height: 200px;
        border: 2px solid #ccc;
        border-radius: 5px;
    }

    p#result {
        margin-top: 20px;
        font-size: 1.5em;
```

```
            font-weight: bold;
            color: #28a745;
            text-align: center;
        }

        p#modelMessage {
            margin-top: 10px;
            font-size: 1.2em;
            text-align: center;
            color: #555;
        }

        p#accuracyMessage {
            margin-top: 10px;
            font-size: 1.1em;
            text-align: center;
            color: #007bff;
        }
    </style>
</head>
<body>
    <h1>Cat and Dog Classifier</h1>
    <form id="uploadForm" enctype="multipart/form-data">
        <label for="file">Upload an Image:</label>
                 <input type="file" id="file" name="file"
accept="image/*" required>
         <img id="previewImage" alt="Selected Image Preview"
style="display: none;">
        <label for="model">Select Model:</label>
        <select id="model" name="model">
            <option value="cnn">CNN</option>
                           <option value="logreg">Logistic
Regression</option>
            <option value="svm">SVM</option>
            <option value="rf">Random Forest</option>
            <option value="kmeans">K-Means</option>
        </select>
        <button type="submit">Classify</button>
    </form>
    <p id="result"></p>
    <p id="modelMessage"></p>
    <p id="accuracyMessage"></p>

    <script>

document.getElementById('file').addEventListener('change',
function () {
            const file = this.files[0];
                                         const    preview    =
document.getElementById('previewImage');
            if (file) {
                const reader = new FileReader();
                reader.onload = function (e) {
                    preview.src = e.target.result;
                    preview.style.display = "block";
                };
                reader.readAsDataURL(file);
            } else {
                preview.src = "";
                preview.style.display = "none";
            }
        });


document.getElementById('uploadForm').addEventListener('subm
it', async (e) => {
            e.preventDefault();
            const formData = new FormData();
                                     formData.append('file',
document.getElementById('file').files[0]);
                                    formData.append('model',
document.getElementById('model').value);

            const response = await fetch('/predict', {
                method: 'POST',
                body: formData
            });

            const data = await response.json();
            if (response.ok) {
```

```
document.getElementById('result').textContent = `Prediction:
${data.result}`;

document.getElementById('modelMessage').textContent =
`Classified using ${data.model} model.`;

document.getElementById('accuracyMessage').textContent =
`Model Accuracy: ${data.accuracy}%`;
             } else {

document.getElementById('result').textContent = `Error:
${data.error}`;
             }
         });
    </script>
</body>
</html>
```

4. Results/Output:-



Cat and Dog Classifier

Upload an Image:

Choose File 00010-4122619883.png

Select Model:

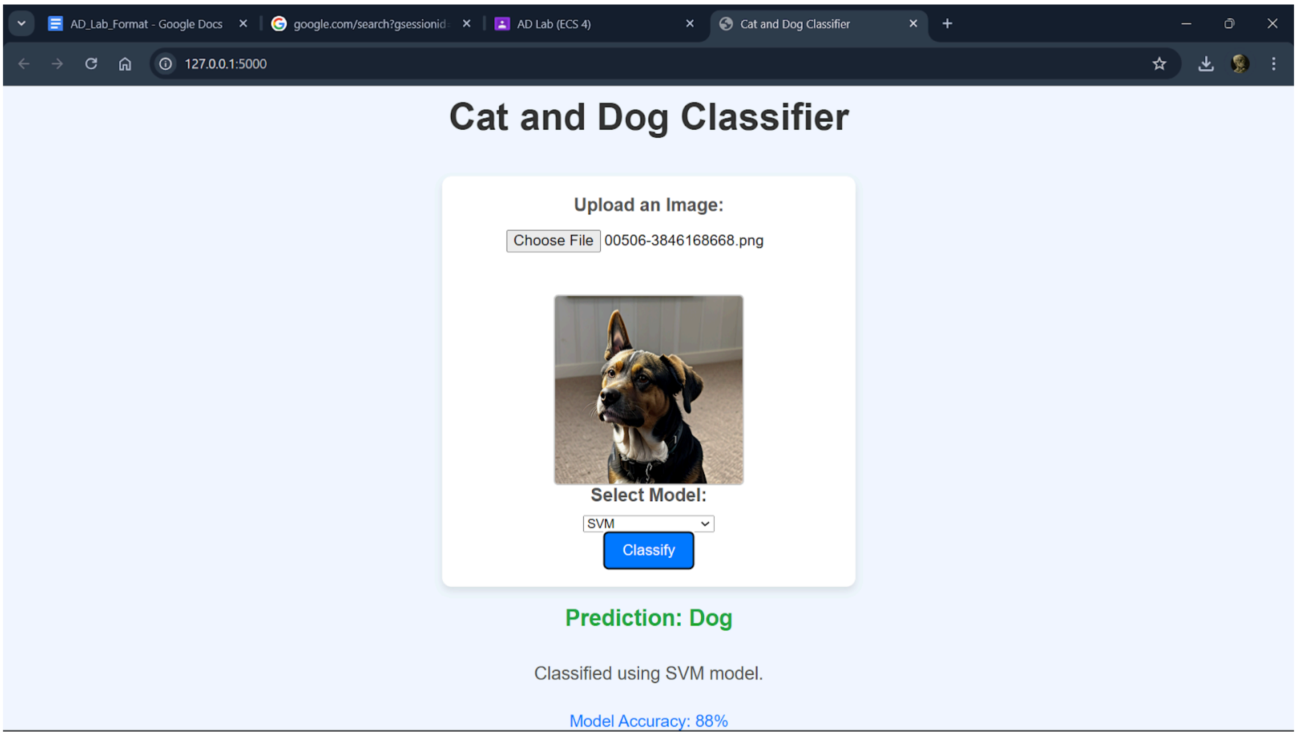
Logistic Regression

Classify

Prediction: Dog

Classified using LOGREG model.

Model Accuracy: 85%



Cat and Dog Classifier

Upload an Image:

Choose File 00506-3846168668.png

Select Model:

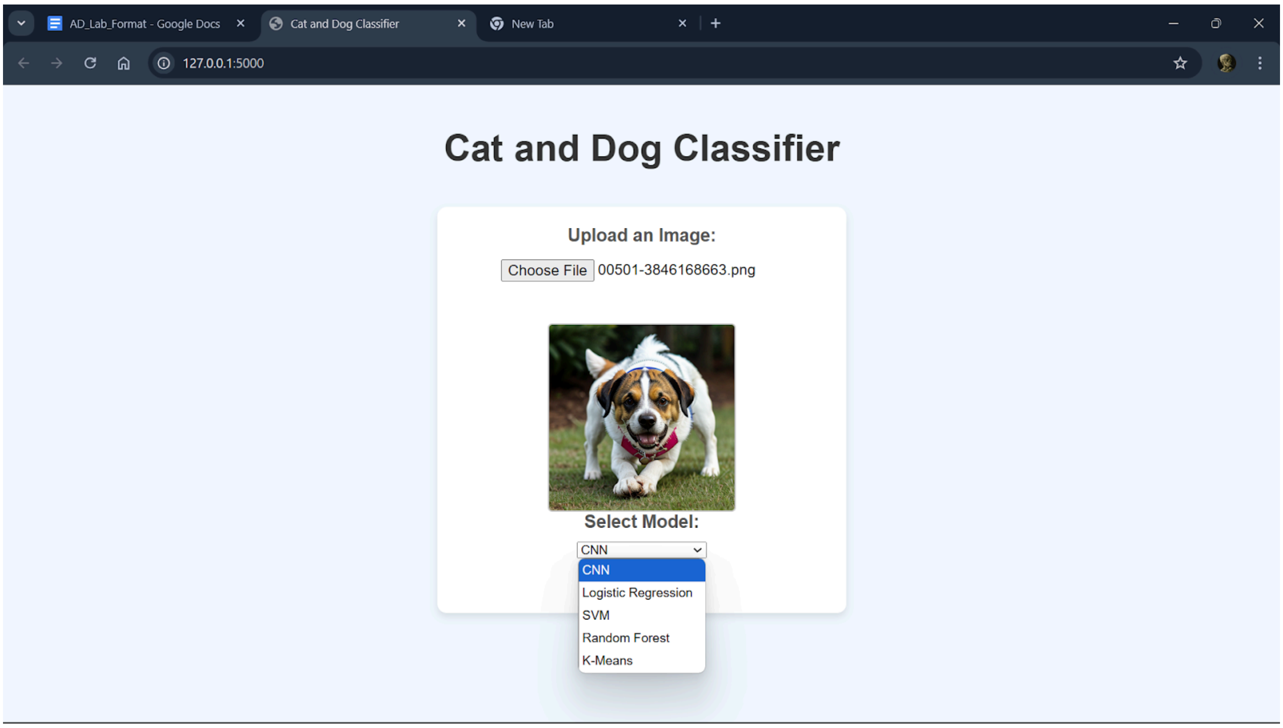
SVM

Classify

Prediction: Dog

Classified using SVM model.

Model Accuracy: 88%



Cat and Dog Classifier

Upload an Image:

Choose File 00501-3846168663.png

Select Model:

CNN

GitHub Repo LInk:

https://github.com/LambodarSarangi-089/Machine-Learning-for-Cat-and-Dog-Classification

5. Remarks:-

This experiment successfully demonstrates the application of machine learning models, including SVM, Random Forest, Logistic Regression, CNN, and K-means Clustering, to classify images of cats and dogs. By integrating preprocessing, model training, and a user-friendly Flask-based interface, it provides a seamless solution for image classification. The results highlight the strengths of different machine learning models in handling image-based tasks and showcase the effectiveness of combining backend and frontend technologies for practical deployment.

Signature of the Student	Signature of the Lab Coordinator
______________________	______________________
Lambodar Sarangi	(Name of the Coordinator)